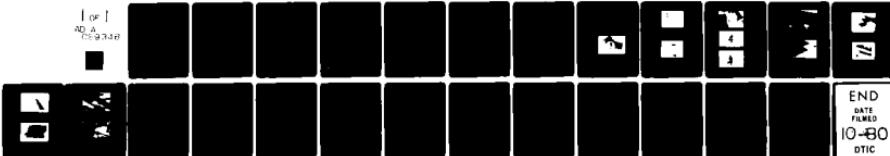


AD-A089 348 ARMY FACILITIES ENGINEERING SUPPORT AGENCY FORT BELV--ETC F/6 14/2
INFRARED UTILIZATION.(U)
APR 80 A J VAN DEN BERG

UNCLASSIFIED USA-FESA-TS-2084

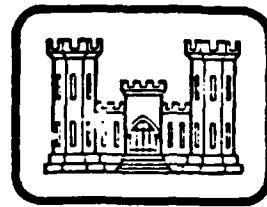
NL

1 of 1
AD-A
059-348



END
DATE FILMED
10-80
DTIC

AD A089348



United States Army
Corps of Engineers

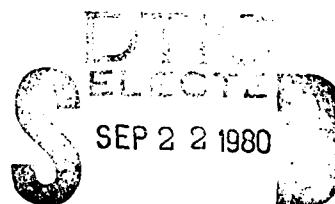
SL *12*
...Serving the Army
...Serving the Nation

FESA-TS-2084

INFRARED UTILIZATION

25 April 1980

Final Report



A

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

DNC FILE COPY

Prepared by:

Alan J. Van den Berg
US Army Facilities Engineering Support Agency
Technology Support Division
Fort Belvoir, VA 22060

80 0 19 028

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
14 744 FESA-TS-2004	2. GOVT ACCESSION NO. <i>AD-A089348</i>	3. RECIPIENT'S CATALOG NUMBER
6 INFRARED UTILIZATION	5. TYPE OF REPORT & PERIOD COVERED <i>Final rept.</i>	4. PERFORMING ORG. REPORT NUMBER
10 Alan J. Van den Berg	7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
9 US Army Facilities Engineering Support Agency Technology Support Division Fort Belvoir, VA 22060	9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11 25 April 1981	11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE
12 25	14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	13. NUMBER OF PAGES <i>14</i>
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
	16. DISTRIBUTION STATEMENT (of this Report)	
	17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)	
	18. SUPPLEMENTARY NOTES	
	19. KEY WORDS (Continue on reverse side if necessary and identify by block number)	
	Infrared Instrumentation Energy Conservation	
	ABSTRACT (Continue on reverse side if necessary and identify by block number) Information regarding the use of infrared instrumentation and where such use may be technologically feasible and cost effective.	

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

411061 744

TABLE OF CONTENTS

	<u>Page</u>
1.0 Introduction	1
2.0 Discussion	1
3.0 Conclusions	2
4.0 Recommendations	3

FIGURES

	<u>Page</u>
Figure 1. A furnace room and latrine wing of an uninsulated building.....	4
Figure 2. Heat escaping from open latrine window, etc.....	4
Figure 3. IR view of a high voltage fuse in sub-station.....	5
Figure 4. IR view of over-heated fuse holders in sub-station.....	5
Figure 5. Steam trap in Laundry.....	6
Figure 6. Good steam trap in IR viewer. Outlet line is cooler than inlet.....	6
Figure 7. Bad steam trap. Note steam in condensate line.....	6
Figure 8. Marked off area on leaking roof.....	7
Figure 9. IR view of area shown above.....	7
Figure 10. IR view of a roof section which is leaking.....	8
Figure 11. Break in unconducted, insulated low temperature heating line buried under macadam street.....	8
Figure 12. Sidewalk over broken HTW line.....	9
Figure 13. HTW line at corner where break was suspected.....	9
Figure 14. Aerial IR view used to find location of buried pipe.....	10
Figure 15. Aerial IR view showing pipe trace.....	10

INFRARED UTILIZATION

1.0 INTRODUCTION

The purpose of this report is to present some information regarding the use of infrared (IR) instrumentation and to inform the Facilities Engineer where such use may be technologically feasible and cost-effective. At present, the state-of-the-art is such that infrared thermography will quantify radiative heat losses but will not quantify total building heat losses. Quantitative measurements are expensive, time consuming and difficult. However, when used or interpreted by experienced personnel, infrared instruments are useful diagnostic tools.

2.0 DISCUSSION

Infrared devices, whether airplane mounted photographic scanners or hand-held thermal radiation probes are basically devices dependent on the intensity of energy radiated in a given wavelength band. When they have scales, they indicate the apparent temperature differences on the surface at which they are aimed or they may indicate the temperature differences between the surface and a built-in standard. However, the readings only indicate the radiation temperature of the surface. Temperature is only one variable in the heat transfer equation. Heat is lost from the building by both radiation and convection. For a determination of these losses, the emissivity, the reflectivity, and conductivity of the walls and roof must be known in addition to the temperature. Figures 1 and 2 are illustrative of the problems involved in trying to quantify heat loss using IR equipment.

2.1 The question of cost effectiveness must be considered since modifications and retrofit of buildings is costly. The savings in fuel costs from reinsulation or modification must be large enough to amortize the cost of the repair and the cost of the IR surveys. Infiltration air in a typical building may account for 40 to 60 percent of the building cooling or heating loss. Losses through walls could be a small percentage. A large amount of productive usage is required to amortize, cost effectively, a 40 thousand dollar IR instrument. Rental of the equipment, procurement of the inspection service, obtaining the service from FESA, or a joint (multi-installation) purchase of the equipment should be analyzed to determine the most cost effective method of accomplishing the task.

2.2 For the present, when qualitative answers are satisfactory, or where radiation temperature differences in themselves are significant indications of trouble, infrared devices make excellent diagnostic aids. One

highly remunerative use of infrared scanners and probes is in connection with the periodic inspection of electric transmission and distribution lines and associated equipment. Loose connections, over-loaded transformers, defective high-voltage switchgear, and other similar problems are readily detected with an infrared scanner (Figure 3, 4). Most importantly, the entire inspection can be accomplished without shutting down any of the power lines. Inspection damage, which often occurs when the joints are mechanically torqued, is completely avoided.

2.3 One use of the infrared scanning which can provide an immediate payoff is in the detection of moisture in the insulation of a flat, built-up roof (Figures 8 through 10). Here there is no quantitative question involved. The location of unwanted water is the pertinent factor. Even though the scanner cannot be used in the daytime because of signal to noise problems caused by the sun, it can be used at night in either the summer or winter. There are two contributing effects. One, heat leaking through the roof from the interior of the building selectively raises the temperature of the more highly conductive wet insulation. Two, the sun's heat raises the roof temperature during the day. At night the wet insulation acts as a heat sink and the surface temperature over the defective insulation is higher than the surrounding roof and the wet spots under the roofing felts can be seen. The method appears to be cost effective since early detection and location of roof leaks can save large amounts of money later on. It is also effective in determining whether a roof can be patched or needs total replacement. Aerial scanning and hand devices are presently being utilized by FESA. The number and extent of the roofs must be considered. So far, work has indicated that aerial scanning will point out places that are candidates for hand-held scanner inspection. From the air, it is difficult to tell the difference between water on the surface of the roof and water under the felts. Nor can differences in radiation temperatures due to different surface emissivities be accounted for. Even when walking a roof with a hand-held device, the answers concerning temperature differences are not always immediately apparent. Varying thicknesses of bitumen cause erratic results. The presence of heated devices, pipes, and ducts, for example, have also given preliminary false indications on the scanner. The time of day, the day and night ambient temperatures, whether or not the building is air-conditioned or heated, and the wavelengths used in the scanner are some of the factors which contribute to the problem of interpreting the IR scans. It appears now that a hand-held infrared scanner is a very effective way to non-destructively test for the presence of water in built-up roofs. The moisture meter can be used during the day but is more time consuming than infrared techniques. Used in conjunction with aerial infrared photography the time to survey can be cut down. Although the nuclear meter has a higher operating cost than the hand-held IR scanner, consideration must be given to the fact that the nuclear meter is significantly less costly than the IR instruments.

3.0 CONCLUSIONS

Infrared thermography has shown its value in a number of applications. It can assist in determining the pattern of power plant hot water effluent in a stream and has been used to detect changes in agricultural growth. It can be used to locate underground steam and hot water lines and leaks (Figure 11 to 15). It cannot pinpoint the location of a leak in systems whose pipes are installed in conduit. Steam traps can be inspected very quickly (Figures 5 through 7). For example, a laundry with 200 steam traps can be inspected by a walk through type survey in 3 to 4 hours. It is recognized that defective steam traps can be identified by relatively unskilled personnel using heat crayons or similar cheap indicating devices. Infrared probes, which are relatively cheap, can also be used. However, if an IR viewer is available, its use is the fastest and easiest method of inspecting steam traps. A programmed inspection of an installations electrical systems (anticipatory maintenance), steam traps, hot water and steam lines, flat roofs, and energy consuming buildings, could be beneficial and cost effective.

4.0 RECOMMENDATIONS

IR scanning devices are tools which can be used effectively. However, there is no substitute for an experienced operator who can make "on the spot" judgements related to causes and effects and pursue elusive clues immediately.

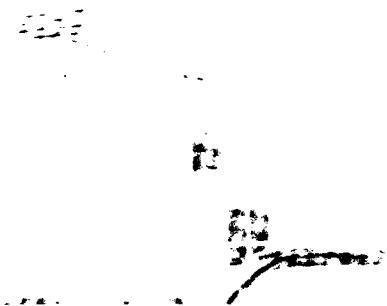


Figure 1. A furnace room and latrine wing of an uninsulated building.



Figure 2. Heat escaping from open latrine window is noticeable. Because of wind induced turbulent air flow on end of building, it appears to be losing less heat than side protected from wind, where air flow is mostly laminar. Actually, most of the heat loss is from the wind swept side of the building. Quantitative determination of heat loss is not possible using the IR equipment alone.

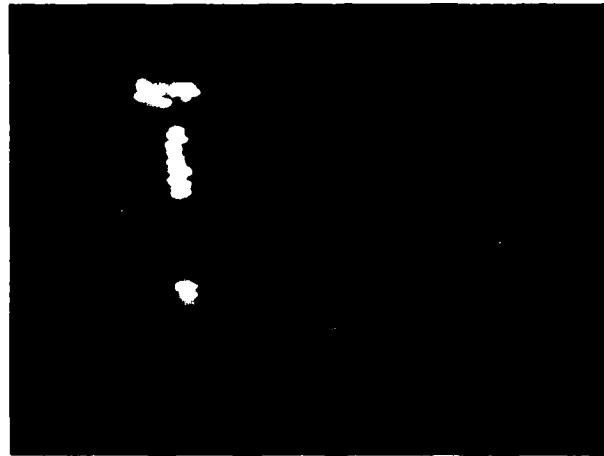


Figure 3. IR view of a high voltage fuse in sub-station. Fuse is over-heated and fuse holders are dirty.



Figure 4. IR view of over-heated fuse holders in sub-station. New equipment made possible these views on a sunlit day.



Figure 5. Steam trap in laundry.

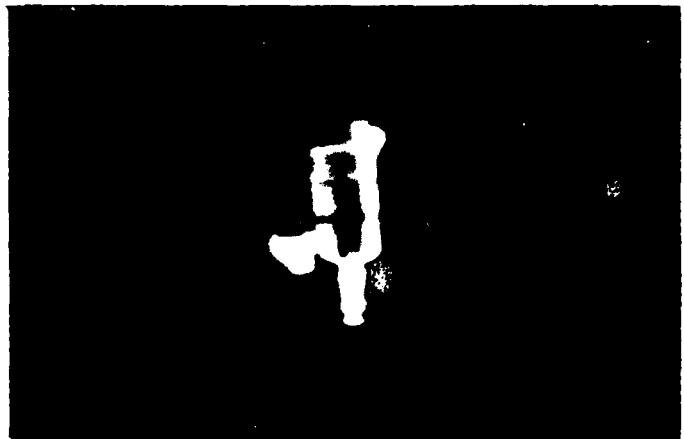


Figure 6. Good steam trap in IR viewer.
Outlet line is cooler than inlet.



Figure 7. Bad steam trap.
Note steam in condensate line.



Figure 8. Marked off area on leaking roof.

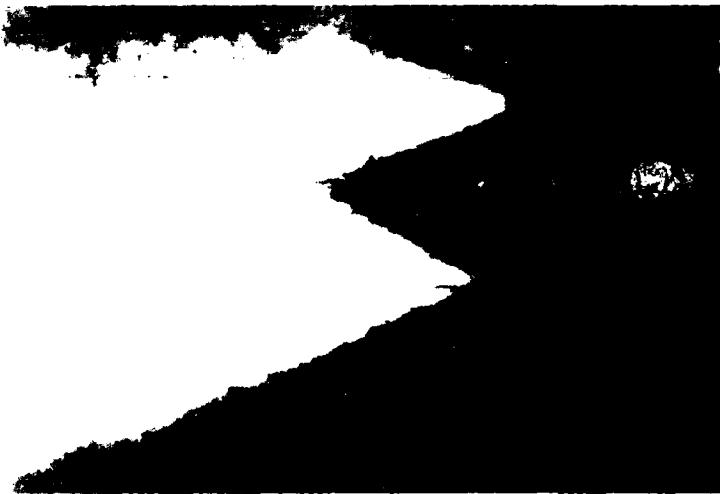


Figure 9. IR view of area shown above.

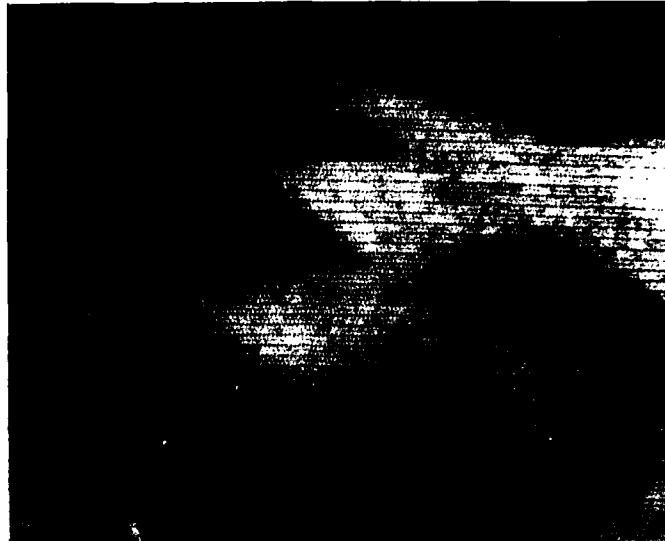


Figure 10. IR view of a roof section which is leaking. Water is being held by individual insulation blocks which are separated by bitumen that has flowed down between them.



Figure 11. Break in uncoated, insulated, low temperature heating line buried under macadam street. Note that heat trace narrows down as the distance from break becomes larger. Straight white line behind trace is curb. Other white is foliage in background.



Figure 12. Sidewalk over broken HTW line.

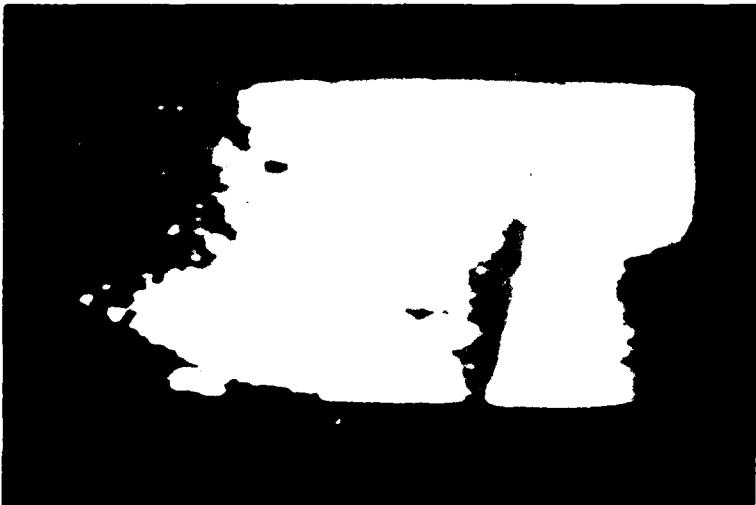


Figure 13. HTW line at corner where break was suspected. This was the lowest point in conduit. Actual pipe break was an eighth of a mile away.



Figure 14. Aerial IR view used to find location of buried pipe.



Figure 15. Aerial IR view showing pipe trace.

DISTRIBUTION LIST

US Military Academy
ATTN: Dept of Mechanics
West Point, NY 10996

US Military Academy
ATTN: Library
West Point, NY 10996

HQDA (DALO-TSE-F)
WASH DC 20314

HQDA (DAEN-ASI-L) (2)
WASH DC 20314

HQDA (DAEN-MPO-B)
WASH DC 20314

HQDA (DAEN-MPR-A)
WASH DC 20314

HQDA (DAEN-MPO-U)
WASH DC 20314

HQDA (DAEN-MPZ-A)
WASH DC 20314

HQDA (DAEN-MPZ-E)
WASH DC 20314

HQDA (DAEN-MPZ-G)
WASH DC 20314

HQDA (DAEM-RDM)
WASH DC 20314

HQDA (DAEN-RDL)
WASH DC 20314

Director, USA-WES
ATTN: Library
PO Box 631
Vicksburg, MS 39181

Commander, TRADOC
Office of the Engineer
ATTN: ATEN
Ft Monroe, VA 23651

Commander, TRADOC
Office of the Engineer
ATTN: ATEN-FE-U
Ft Monroe, VA 23651

AF Civil Engr Center/XRL
Tyndall AFB, FL 32401

Naval Facilities Engr Command
ATTN: Code 04
200 Stovall St.
Alexandria, VA 22332

Defense Documentation Center
ATTN: TCA (12)
Cameron Station
Alexandria, VA 22314

Commander and Director
USA Cold Regions Research Engineering
Laboratory
Hanover, NH 03755

FORSCOM
ATTN: AFEN
Ft McPherson, GA 30330

FORSCOM
ATTN: AFEN-FE
Ft McPherson, GA 30330

Officer-in-Charge
Civil Engineering Laboratory
Naval Construction Battalion Center
ATTN: Library (Code L08A)
Port Hueneme, CA 93043

Commander and Director
USA Construction Engineering
Research Laboratory
PO Box 4005
Champaign, IL 61820

Commanding General, 3d USA
ATTN: Engineer
Ft McPherson, GA 30330

DIST 1

Commanding General, 5th USA
ATTN: Engineer
Ft Sam Houston, TX 78234

AFCE Center
Tyndall AFB, FL 32403

Commander, DARCOM
Director, Installation
and Services
5001 Eisenhower Ave
Alexandria, VA 22333

Commander, DARCOM
ATTN: Chief, Engr Div
5001 Eisenhower Ave
Alexandria, VA 22333

Air Force Weapons Lab/AFWL/DE
Chief, Civil Engineering
Research Division
Kirtland AFB, NM 87117

Strategic Air Command
ATTN: DSC/CE (DEEE)
Offutt AFB, NE 68112

Headquarters USAF
Directorate of Civil Engineering
AF/PREES
Bolling AFB
Washington, DC 20333

Strategic Air Command
Engineering
ATTN: Ed Morgan
Offutt AFB, NE 68113

USAF Institute of Technology
AFIT/DED
Wright Patterson AFB, OH 45433

Air Force Weapons Lab
Technical Library (DOUL)
Kirtland AFB, FL 87117

Chief, Naval Facilities
Engineer Command
ATTN: Chief Engineer
Department of the Navy
Washington, DC 20350

Commander
Naval Facilities Engineering Cmd
200 Stovall St
Alexandria, VA 22332

Commander
Naval Facilities Engr Cmd
Western Division
Box 727
San Bruno, CA 94066

Civil Engineering Center
ATTN: Moreell Library
Port Hueneme, CA 93043

Commandant of the Marine Corps
HQ, US Marine Corps
Washington, DC 20380

National Bureau of Standards (4)
Materials & Composites Section
Center for Building Technology
Washington, DC 20234

Assistant Chief of Engineers
Room 1E 668, Pentagon
Washington, DC 20310

The Army Library (ANRAL-R)
ATTN: Army Studies Section
Room 1A 518, The Pentagon
Washington, DC 20310

Commander-in Chief
USA, Europe
ATTN: AEAEN
APO New York, NY 09403

Commander
USA Foreign Science and
Technology Center
220 8th St. N.E.
Charlottesville, VA 22901

Commander
USA Science & Technology
Information Team, Europe
APO New York 09710

Commander
USA Science & Technology
Center - Far East Office
APO San Francisco 96328

Commanding General
US Engineer Command, Europe
APO New York 09403

Deputy Chief of Staff
for Logistics
US Army, The Pentagon
Washington, DC 20310

Commander, TRADOC
Office of the Engineer
ATTN: Chief, Facilities
Engineering Division
Ft Monroe, VA 23651

Commanding General
USA Forces Command
Office of the Engineer
(AFEN-FES)
Ft McPherson, GA 30330

Commanding General
USA Forces Command
ATTN: Chief, Facilities
Engineering Division
Ft McPherson, GA 30330

Commanding General, 1st USA
ATTN: Engineer
Ft George G. Meade, MD 20755

Commander
USA Support Command, Hawaii
Fort Shafter, HI 96858

Commander
Eighth US Army
APO San Francisco 96301

Commander
US Army Facility Engineer
Activity - Korea
APO San Francisco 96301

Commander
US Army, Japan
APO San Francisco 96343

Facilities Engineer
Fort Belvoir
Fort Belvoir, VA 22060

Facilities Engineer
Fort Benning
Fort Benning, GA 31905

Facilities Engineer
Fort Bliss
Fort Bliss, TX 79916

Facilities Engineer
Carlisle Barracks
Carlisle Barracks, PA 17013

Facilities Engineer
Fort Chaffee
Fort Chaffee, AR 72902

Facilities Engineer
Fort Dix
Fort Dix, NY 08640

Facilities Engineer
Fort Eustis
Fort Eustis, VA 23604

Facilities Engineer Fort Gordon Fort Gordon, GA 30905	Facilities Engineer Fort Story Fort Story, VA 23459
Facilities Engineer Fort Hamilton Fort Hamilton, NY 11252	Facilities Engineer Kansas Army Ammunition Plant Independence, MO 64056
Facilities Engineer Fort A P Hill Bowling Green, VA 22427	Facilities Engineer Lone Star Army Ammunition Plant Texarkana, TX 75501
Facilities Engineer Fort Jackson Fort Jackson, SC 29207	Facilities Engineer Picatinny Arsenal Dover, NJ 07801
Facilities Engineer Fort Knox Fort Knox, KY 40121	Facilities Engineer Louisiana Army Ammunition Plant Shreveport, LA 71130
Facilities Engineer Fort Lee Fort Lee, VA 23801	Facilities Engineer Milan Army Ammunition Plant Warren, MI 48089
Facilities Engineer Fort McClellan Fort McClellan, AL 36201	Facilities Engineer Pine Bluff Arsenal Pine Bluff, AR 71601
Facilities Engineer Fort Monroe Fort Monroe, VA 23651	Facilities Engineer Radford Army Ammunition Plant Radford, VA 24141
Facilities Engineer Presidio of Monterey Presidio of Monterey, CA 93940	Facilities Engineer Rock Island Arsenal Rock Island, IL 61201
Facilities Engineer Fort Pickett Blackstone, VA 23824	Facilities Engineer Rocky Mountain Arsenal Dever, CO 80340
Facilities Engineer Fort Rucker Fort Rucker, AL 36362	Facilities Engineer Scranton Army Ammunition Plant 156 Cedar Avenue Scranton, PA 18503
Facilities Engineer Fort Sill Fort Sill, OK 73503	Facilities Engineer Tobyhanna Army Depot Tobyhanna, PA 18466

Facilities Engineer
Tooele Army Depot
Tooele, UT 84074

Facilities Engineer
Arlington Hall Station
400 Arlington Blvd
Arlington, VA 22212

Facilities Engineer
Cameron Station, Bldg 17
5010 Duke Street
Alexandria, VA 22314

Facilities Engineer
Sunny Point Military
Ocean Terminal
Southport, NC 28461

Facilities Engineer
US Military Academy
West Point Reservation
West Point, NY 10996

Facilities Engineer
Fort Ritchie
Fort Ritchie, MD 21719

Facilities Engineer
Army Materials & Mechanics
Research Center
Watertown, MA 02172

Facilities Engineer
Ballistics Missile Advanced
Technology Center
PO Box 1500
Huntsville, AL 35807

Facilities Engineer
Fort Wainwright
172d Infantry Brigade
Fort Wainwright, AK 99703

Facilities Engineer
Fort Greely
172d Infantry Brigade
Fort Richardson, AK 99505

Facilities Engineer
Tarheel Army Missile Plant
204 Granham-Hopedale Rd
Burlington, NC 27215

Facilities Engineer
Harry Diamond Laboratories
2800 Powder Mill Rd
Adelphi, MD 20783

Facilities Engineer
Fort Missoula
Missoula, MT 59801

Facilities Engineer
New Cumberland Army Depot
New Cumberland, PA 17070

Facilities Engineer
Oakland Army Base
Oakland, CA 94626

Facilities Engineer
Vint Hill Farms Station
Warrentown, VA 22186

Facilities Engineer
Twin Cities Army Ammunition Plant
New Brighton, MN 55112

Facilities Engineer
Volunteer Army Ammunition Plant
Chattanooga, TN 37401

Facilities Engineer
Watervliet Arsenal
Watervliet, NY 12189

Facilities Engineer
St Louis Area Support Center
Granite City, IL 62040

Facilities Engineer
Fort Monmouth
Fort Monmouth, NJ 07703

Facilities Engineer
Redstone Arsenal
Redstone Arsenal, AL 35809

Facilities Engineer Detroit Arsenal Warren, MI 48039	Facilities Engineer Fort Hood Fort Hood, TX 76544
Facilities Engineer Aberdeen Proving Ground Aberdeen Proving Ground, MD 21005	Facilities Engineer Fort Indiantown Gap Annville, PA 17003
Facilities Engineer Jefferson Proving Ground Madison, IN 47250	Facilities Engineer Fort Lewis Fort Lewis, WA 98433
Facilities Engineer Dugway Proving Ground Dugway, UT 84022	Facilities Engineer Fort MacArthur Fort MacArthur, CA 90731
Facilities Engineer Fort McCoy Sparta, WI 54656	Facilities Engineer Fort McPherson Fort McPherson, GA 30330
Facilities Engineer White Sands Missile Range White Sands Missile Range, NM 88002	Facilities Engineer Fort George G. Meade Fort George G. Meade, MD 20755
Facilities Engineer Yuma Proving Ground Yuma, AZ 85364	Facilities Engineer Fort Polk Fort Polk, LA 71459
Facilities Engineer Natick Research & Dev Ctr Kansas St. Natick, MA 01760	Facilities Engineer Fort Riley Fort Riley, KS 66442
Facilities Engineer Fort Bragg Fort Bragg, NC 28307	Facilities Engineer Fort Stewart Fort Stewart, GA 31312
Facilities Engineer Fort Campbell Fort Campbell, KY 42223	Facilities Engineer Indiana Army Ammunition Plant Charlestown, IN 47111
Facilities Engineer Fort Carson Fort Carson, CO 80913	Facilities Engineer Joliet Army Ammunition Plant Joliet, IL 60436
Facilities Engineer Fort Drum Watertown, NY 13601	Facilities Engineer Anniston Army Depot Anniston, AL 36201

Facilities Engineer
Corpus Christi Army Depot
Corpus Christi, TX 78419

Facilities Engineer
Red River Army Depot
Texarkana, TX 75501

Facilities Engineer
Sacramento Army Depot
Sacramento, CA 95813

Facilities Engineer
Sharpe Army Depot
Lathrop, CA 95330

Facilities Engineer
Seneca Army Depot
Romulus, NY 14541

Facilities Engineer
Fort Ord
Fort Ord, CA 93941

Facilities Engineer
Presidio of San Francisco
Presidio of San Francisco, CA 94129

Facilities Engineer
Fort Sheridan
Fort Sheridan, IL 60037

Facilities Engineer
Holston Army Ammunition Plant
Kingsport, TN 37662

Facilities Engineer
Baltimore Outport
Baltimore, MD 21222

Facilities Engineer
Bayonne Military Ocean Terminal
Bayonne, NJ 07002

Facilities Engineer
Bay Area Military Ocean Terminal
Oakland, CA 94626

Facilities Engineer
Gulf Outport
New Orleans, LA 70146

Facilities Engineer
Fort Huachuca
Fort Huachuca, AZ 86513

Facilities Engineer
Letterkenny Army Depot
Chambersburg, PA 17201

Facilities Engineer
Michigan Army Missile Plant
Warren, MI 48089

COL E. C. Lussier
Fitzsimons Army Med Center
ATTN: HSF-DFE
Denver, CO 80240

US Army Engr Dist, New York
ATTN: NANEN-E
26 Federal Plaza
New York, NY 10007

USA Engr Dist, Baltimore
ATTN: Chief, Engr Div
PO Box 1715
Baltimore, MD 21203

USA Engr Dist, Charleston
ATTN: Chief, Engr Div
PO Box 919
Charleston, SC 29402

USA Engr Dist, Detroit
PO Box 1027
Detroit, MI 48231

USA Engr Dist, Kansas City
ATTN: Chief, Engr Div
700 Federal Office Bldg
601 E 12th St
Kansas City, MO 64106

USA Engr Dist, Omaha
ATTN: Chief, Engr Div
7410 USOP and Courthouse
215 N. 17th St
Omaha, NE 68102

USA Engr Dist, Fort Worth
ATTN: Chief, SWFED-D
PO Box 17300
Fort Worth, TX 76102

USA Engr Dist, Sacramento
ATTN: Chief, SPKED-D
650 Capitol Mall
Sacramento, CA 95814

USA Engr Dist, Far East
ATTN: Chief, Engr Div
APO San Francisco, CA 96301

USA Engr Dist, Japan
APO San Francisco, CA 96343

USA Engr Div, Europe
European Div, Corps of Engineers
APO New York, NY 09757

USA Engr Div, North Atlantic
ATTN: Chief, NADEN-T
90 Church St
New York, NY 10007

USA Engr Div, South Atlantic
ATTN: Chief, SAEN-TE
510 Title Bldg
30 Pryor St, SW
Atlanta, GA 30303

USA Engr Dist, Mobile
ATTN: Chief, SAMEN-C
PO Box 2288
Mobile, AL 36601

USA Engr Dist, Louisville
ATTN: Chief, Engr Div
PO Box 59
Louisville, KY 40201

USA Engr Div, Norfolk
ATTN: Chief, NAOEN-D
803 Front Street
Norfolk, VA 23510

USA Engr Div, Missouri River
ATTN: Chief, Engr Div
PO Box 103 Downtown Station
Omaha, NE 68101

USA Engr Div, South Pacific
ATTN: Chief, SPDED-TG
630 Sansome St, Rm 1216
San Francisco, CA 94111

USA Engr Div, Huntsville
ATTN: Chief, HNDED-ME
PO Box 1600 West Station
Huntsville, AL 35807

USA Engr Div, Ohio River
ATTN: Chief, Engr Div
PO Box 1159
Cincinnati, OH 45201

USA Engr Div, North Central
ATTN: Chief, Engr Div
536 S. Clark St.
Chicago, IL 60605

USA Engr Div, Southwestern
ATTN: Chief, SWDED-TM
Main Tower Bldg, 1200 Main St
Dallas, TX 75202

USA Engr Dist, Savannah
ATTN: Chief, SASAS-L
PO Box 889
Savannah, GA 31402

Commander
US Army Facilities Engineering
Support Agency
Support Detachment II
Fort Gillem, GA 30050

Commander
US Army Facilities Engr Spt Agency
ATTN: MAJ Brisbane
Support Detachment III
PO Box 6550
Fort Bliss, TX 70015

NCOIC
US Army Facilities Engr Spt Agency
Support Detachment III
ATTN: FESA-III-SI
PO Box 3031
Fort Sill, OK 73503

NCOIC
US Army Facilities Engr Spt Agency
Support Detachment III
ATTN: FESA-III-PR
PO Box 29704
Presidio of San Francisco, CA 94129

NCOIC
US Army Facilities Engr Spt Agency
ATTN: FESA-III-CA
Post Locator
Fort Carson, CO 80913

Commander/CPT Ryan
US Army Facilities Engr Spt Agency
Support Detachment IV
PO Box 300
Fort Monmouth, NJ 07703

NCOIC
US Army Facilities Engr Spt Agency
ATTN: FESA-IV-MIJ
PO Box 300
Fort Monmouth, NJ 07703

NCOIC
US Army Facilities Engr Spt Agency
Support Detachment IV
ATTN: FESA-IV-ST
Stewart Army Subpost
Newburgh, NY 12250

NCOIC
US Army Facilities Engineering
Support Agency
Support Detachment II
ATTN: FESA-II-JA
Fort Jackson, SC 29207

NCOIC
US Army Facilities Engr Spt Agency
Support Detachment II
PO Box 2207
Fort Benning, GA 31905

NCOIC
US Army Facilities Engr Spt Agency
Support Detachment II
ATTN: FESA-II-KN
Fort Knox, KY 40121

Naval Facilities Engineering Cmd
Energy Programs Branch, Code 1023
Hoffman Bldg 2, (Mr. John Hughes)
Stovall Street
Alexandria, VA 22332

US Army Facilities Engineering
Support Agency
FE Support Detachment I
APO New York 09081

Navy Energy Office
ATTN: W. R. Mitchum
Washington, DC 20350

Mr. David C. Hall
Energy Projects Officer
Dept of the Air Force
Sacramento Air Logistics
Center (AFLEC)
2852 ABG/DEE
Ft McClellan, CA 95652

USA Engineer District, Chicago
219 S. Dearborn Street
ATTN: District Engineer
Chicago, IL 60604

Directorate of Facilities Engineering
Energy Environmental and
Self Help Center
Fort Campbell, KY 42223

Commander and Director
Construction Engineering
Research Laboratory
ATTN: COL Circeo
PO Box 4005
Champaign, IL 61820

Mr. Ray Heller
Engineering Services Branch
DFAE, Bldg 1950
Fort Sill, OK 73503

HQ, US Military Community Activity,
Heilbronn
Director of Engineering & Housing
ATTN: Mr. Rodger D. Romans
APO New York 09176

Commanding General
HQ USATC and Fort Leonard Wood
ATTN: Facility Engineer
Fort Leonard Wood, MO 65473

NCOIC
535th Engineer Detachment, Team A
ATTN: SFC Prenger
PO Box 224
Fort Knox, KY 40121

NCOIC
535th Engineer Detachment, Team B
ATTN: SP6 Cathers
PO Box 300
Fort Monmouth, NJ 07703

NCOIC
535th Engineer Detachment, Team C
ATTN: SFC Jackson
PO Box 4301
Fort Eustis, VA 23604

NCOIC
535th Engineer Detachment, Team D
ATTN: SFC Hughes
Stewart Army Subpost
Newburg, NY 12550

Commander-in-Chief
HQ, USAREUR
ATTN: AEAEN-EH-U
APO New York 09403

HQ AFESC/RDVA
Mr. Hathaway
Tyndall AFB, FL 32403

Commander and Director
Construction Engineering Research
Laboratory
ATTN: Library
PO Box 4005
Champaign, IL 61820

HQ, 5th Signal Command
Office of the Engineer
APO New York 09056

SSG Ruiz Burgos Andres
D.F.E., HHC HQ Cmd 193d Inf
BDE
Ft Clayton, C/Z

Energy//Environmental Office
ATTN: Mr. David R. Nichols
USMCA-NBG (DEH)
APO New York 09696

Commander
535th Engineer Detachment
PO Box 300
Fort Monmouth, NJ 07703

Commander
Presidio of San Francisco,
California
ATTN: AFZM-DI/Mr. Prugh
San Francisco, CA 94129

Facilities Engineer
Corpus Christi Army Depot
ATTN: Mr. Joseph Canpu/Stop 24
Corpus Christi, TX 78419

Walter Reed Army Medical Center
ATTN: HSWS-E/Mr. James Prince
6825 16th St., NW
Washington, DC 20012

Commanding Officer
Installations and Services Activity
ATTN: DRCIS-RI-IB
Rock Island Arsenal
Rock Island, IL 61299

Commanding Officer
Northern Division Naval
Facilities Engineering Command
Code 102 (Mr. E. F. Humm)
Naval Base
Philadelphia, PA 19112

Commander
US Army Facilities Engineering
Support Agency
Support Detachment I
APO New York 09081

Commanding Officer
Northern Division Naval
Facilities Engineering Command
Code 10
Naval Base, Building 77
Philadelphia, PA 19112

Facilities Engineer
Fort Leavenworth
Fort Leavenworth, KS 66027

Facilities Engineer
Fort Benjamin Harrison
Fort Benjamin Harrison, IN 46216